Q2. What signal form is anticipated for use in the studio for program origination for your system? Are there different levels of quality and cost possible? If so, what are they and how are they accomplished? What are the trade-offs? What level of performance is achieved by each?

NHK

1. The SMPTE 240M signal format will be used for program origination for Narrow MUSE.

2. It is not a good idea to introduce an intermediate production format to reduce costs for broadcasters. This will lead to confusion and cost more in total to upgrade through the intermediate level to true HDTV equipment.

3. At the very beginning of the service, NTSC or widescreen 525-line components can be used with upconversion to 240M. An upconverter is already on the market.

GI

1. The input to the DigiCipher encoder is 1050/59.94/2:1. SMPTE 240M-type signals at 1125/59.94/2:1 can also be used with a transconverter to 1050. The quality loss of such a conversion is very small and usually not perceptible.

2. Use of 240M-type equipment is expected in the early stages because of the variety available.

3. "Pro compression" may be possible and is viewed as being intra-frame only, with data rates in the 100-200 Mb/s range. Pro compressions is assumed to be available eventually but possibly not in the early days of the HDTV broadcast service.

4. No compatibility problems between pro compression and DigiCipher compression are anticipated.

Zenith/ATT

1. For normal studio program sources: 787/59.94/1:1, GBR component signals. YUV component signals may be a good alternative for practical reasons. Lower quality can be obtained from upconverting widescreen 525/59.94/2:1 GBR component signals. Composite NTSC is also possible for even lower quality.

2. A two-dimensionally (2D) compressed version of the same signal is seen as an alternative requiring 200 Mb/s. This could be used in compressed form for scene cuts but would require decoding for other processing or image manipulation. Decoding to analog components is not necessary or desirable. Multiple digital-only encode/decode concatenations at 200 Mb/s are expected to be virtually transparent.

3. The 200 Mb/s signal may not support all studio operations without decoding but provides convenient single wire transport and switching. Using it for additional production processes is still under investigation.

, ATRC

1. A variety of signal forms is anticipated. The AD-HDTV system design anticipates several levels of related MPEG compression that will support a variety of quality/cost levels. MPEG fully supports both interframe and intraframe compression.

2. Cameras will likely use 1050-line rasters with uncompressed data in the range of 620 — 1000 Mb/s. Studio recorders will likely be offered in different levels of cost and performance based on various levels of compression and/or subsampling, e.g. modest intraframe compression, yielding 216 Mb/s, could be recorded with D-1 technology at relatively modest cost.

3. MPEG compression at 216 Mb/s will be extremely high quality and likely will be intraframe. At such a high data rate, concatenated compressions and decompressions should not be a problem. The approach should help reduce costs of recording, distribution, and switching equipment.

4. The scanning format and compression approach should be related to the terrestrial broadcasting standard, but the appropriate quality of compression and bit rates should be set by an industry organization such as SMPTE.

MIT

1. Signal formats expected for studio production initially are 720/59.94/1:1, 720/30/1:1, and 720/24/1:1, where 720 represents number of active lines. Later, 1080/30/1:1 is anticipated. Frame header will specify signal format used in transmission. At receiver, frame header will cause appropriate decoding and display of data consistent with the receiver display.

2. Any signal form is possible through source adaptivity.

3. The signal compression scheme can be used for production by increasing the allocated bit rate. At 180 Mb/s, a raster of 1280 x 720 pixels/frame at 60 frames/second would be indistinguishable from the original.

4. The 180 Mb/s compressed form would have to be decompressed prior to cutting, keying, or image manipulation.

5. The adequacy of the 180 Mb/s form has been examined using a computer simulation with a limited amount of data. This must be verified with a much more extensive set of data.

Q3. What signal form is anticipated for use in distribution to Network affiliates and/or to cable headends? Have you anticipated both satellite and terrestrial common carrier delivery? Have these been tested experimentally?

NHK

1. Two options:

   - Digitally compressed SMPTE 240M signal. Bit rate will be approximately 60 Mb/s.
   - Digital version of Narrow MUSE. Bit rate will be approximately 40 Mb/s after further compression of the N-MUSE signal.

2. Digital N-MUSE signal is further compressed using DPCM or similar technique, requiring less than 2:1 ratio. Compression is applied to digital version of N-MUSE extracted prior to modulator that generates analog signal for transmission.

3. Both satellite and terrestrial common carrier delivery anticipated. Schemes not tested for N-MUSE but similar to one used in service for fullband MUSE.

GI

1. During early years, distribution of the transmission signal is expected. Pass through operation will be principal method, with minimal local editing.

2. Over time, migration to a higher level DigiCipher feed ("distribution level") is expected from networks. While not lossless, this signal will have a data rate in the 30-40 Mb/s and be more transparent to editing.

3. DigiCipher compression at 30 Mb/s has been simulated with very pleasing results. Hardware tests are expected in the near future. Higher data rates will also be tried.

4. DigiCipher algorithm incorporates interframe coding and adaptively processes in field and frame modes.

5. Both satellite and fiber optic transmission can be used.

6. Satellites would use QPSK modulation. DigiCipher QPSK has been tested using the related multichannel NTSC system. Fiber optic and coaxial transmission have been tested by CableLabs during ATTC testing.

Zenith/ATT

1. Fully compressed form at a maximum data rate of 21.5 Mb/s is expected for distribution to "minimal television station." Terrestrial common carrier facilities capable of 21.5 Mb/s serial data will be suitable. The satellite version is being tested with Scientific Atlanta. Same signal also appropriate for distribution to cable headends where pass-through is primary requirement.

2. For "transitional television station," where only limited post production is usually required, 100 Mb/s, 2D compressed signal is proposed. This could be sent over one satellite channel.

3. Both proposed rates, 21.5 & 100 Mb/s, would have to be supported by both satellite and common carrier distribution. Neither has been tested experimentally.

ATRC

1. MPEG compressed video at data rates well within satellite or terrestrial capability is anticipated.

2. MPEG compression carefully related to the terrestrial broadcast standard is the best choice. Issue of an appropriate quality/bit rate that takes account of subsequent compression/decompression should be addressed and standardized by an industry organization such as SMPTE.

3. During the transition period to HDTV, distribution will most frequently be a the compression level used for transmission. Local stations will perform minimal decompression and processing of the signal.

MIT

1. Both satellite and fiber optic transmission can be used.

2. Satellites would use QPSK modulation.

3. Initially, broadcast and cable networks will distribute signals at the transmission level of compression with emphasis on pass-through. There will be minimal local editing.

4. Later, distribution signals with bit rates between transmission and production levels will be used. The bit rate expected for such signals will be in the 30-50 Mb/s range. Interframe compression is anticipated.

24. What forms of further production are possible using the signal delivered to affiliates and headends?

    a) cut into the signal
    b) key into the signal
    c) full image manipulation

NHK

1. With a digitally compressed SMPTE 240M signal at 60 Mb/s, all three processes are possible. The signal must be decoded to permit the three forms of processing.

2. With a digital N-MUSE signal at 40 Mb/s, only cuts are possible in the Narrow MUSE domain, as for commercial insertion.

GI

1. Cutting and keying may be possible without full decode/reencode, but full image manipulation will require full decode/reencode. This assumes use of the transmission level signal, the most demanding case.

2. Cuts would most effectively occur on frame boundaries. A cut-in should start with a PCM frame, which occurs on scene change. Cuts are most easily accomplished when both signals are at black.

Zenith/ATT

1. For the fully compressed, 21.5 Mb/s signal, because of the motion compensation used in the image compression, only cuts into the signal are possible. If done randomly, the artifacts introduced are similar to a channel change at a consumer receiver, with reacquisition in a few frames.

2. Clean cuts to and from black and at scene changes are believed possible without decoding.

3. For a two-dimensional distribution compression, cuts can be made at any time. Other processing appears to require decoding at least to digital components.

ATRC

1. Cuts may be achieved directly in compressed form if modest spatial compression (no motion compensation) is used.

2. High quality keys and full image manipulation require decompression of the video for processing.

3. Economic factors will be weighed against cost and quality of compression/ decompression to determine appropriate distribution formats for different applications and markets.

4. MPEG has unique advantage of spatially-coded frames on a periodic basis, allowing artifact-free cuts on Group of Pictures (GOP) boundaries, even in highly compressed transmission format. MPEG has further advantage that higher bit rates can be used with a different GOP structure to allow more accurate cuts in higher-quality signals.

5. Most production processes will require full decoding, although some might be achieved with partial decoding.

6. Signals with modest compression likely will be found in production and post-production equipment and contribution links, as described in the answer to B.2.

MIT

1. Cutting, keying, and image manipulation are all possible by first decoding the signal.

2. There is a possibility of partial decompression for further production. This would involve a fair amount of processing. It would be easier to decompress the signal fully.

Q5. If the signal delivered to affiliates/headends must be fully decoded for further production, in the forms listed in 4 above, how many times can this be done with acceptable quality in the resulting picture? Have you tested this experimentally?

NHK

1. If a digitally compressed SMPTE 240M signal at 60 Mb/s is used, the number of coding/decoding concatenations is two to maintain acceptable picture quality. This has not been tested.

2. It is assumed that, when digitally compressed N-MUSE is used for distribution, only the digital compression will be decoded, and N-MUSE will not be decoded. Signal processing is thus limited to cuts only. Concatenations of coding/decoding of the digital compression of N-MUSE are limited to two to maintain acceptable picture quality.

GI

1. Multiple pass encode/decode results in only modest loss in quality. Two pass concatenation has been tested. DigiCipher can support higher rate encoding for distribution to yield even less quality loss. Concatenation with a 45 Mb/s encoding scheme has also yielded only modest loss of quality.

Zenith/ATT

1. Cutting, keying, and full image manipulation are possible if the signal is decompressed, with resulting image quality being image dependent. Some non-real time simulations indicate this can be done several times without degradation, but results are source-signal dependent.

2. Decode/encode concatenation is most tolerant when decoded only to digital components.

3. Concatenation of the 21.5 Mb/s signal can leave image (hence source) content dependent artifacts. Artifacts are more likely as image complexity increases in all digital systems and depends on the algorithm used.

4. Concatenation of the 100 Mb/s encode/decode process is expected to be virtually transparent to 21.5 Mb/s transmission. Several concatenations should be possible with no noticeable artifacts following 21.5 Mb/s encoding/decoding.

5. Studies are being conducted with computer simulations.

ATRC

1. Uncompressed signals may be handled identically to CCIR 601 signals in a digital plant. Acceptable limits of compression/decompression in a post-processing environment are scene-dependent.

2. Most further processing at local stations will require full decoding, although some might be achieved with partial decoding.

3. The Group of Pictures structure of MPEG has an advantage for coding/decoding concatenation since I, P, and B frame types can be coded in the same way in subsequent coding. While doing so will improve concatenated quality, it is not necessary, and it imposes no constraint.

MIT

1. Extensive multi-generation compression and decompression simulations have not been performed.

2. Based on limited simulations, multi-generation compression and decompression should be avoided for transmission signals but are possible for production signals.

26. Is it possible to carry the ATV signals and NTSC signals together on a single microwave channel, as for Studio-to-Transmitter Links (STLs) and similar circuits? If so, what is the required bandwidth?

NHK

1. Analog microwave links can be used with FM if 45 MHz bandwidth is available. Both NTSC and N-MUSE would need 17 MHZ, and a wide guardband is required to account for filter characteristics.

2. Digital microwave links can be used with QPSK and a bandwidth of 34 MHz. N-MUSE would require 40 Mb/s and NTSC 17 Mb/s.

3. To transmit both over a 25 MHz channel, digital compression with the same data rates of 40 Mb/s for N-MUSE and 17 Mb/s for NTSC can be used with 8φ PSK. QPSK could be used if a slightly higher compression ratio is applied.

GI

1. Required bandwidth depends upon type of modulation. With 32-QAM, one ATV and one NTSC signal can be carried in 9 MHz for the STL. FDM is believed more appropriate than TDM. 32-QAM is more spectrum than QPSK, although either could be used.

Zenith/ATT

1. Analog microwave links likely not to be able to pass analog NTSC with compressed DSC-HDTV because of intermodulation.

2. Compressed digital NTSC, frequency multiplexed with compressed DSC-HDTV, is possible on analog microwave links with a bandwidth of 10 to 12 MHz and a 3 MHz guardband between the two.

3. Digital microwave links would require 30 to 36 Mb/s to carry a multiplex of DSC-HDTV and compressed NTSC, depending upon the acceptable NTSC data rate (3.5 to 8.5 Mb/s) and assuming 20 per cent FEC overhead.

ATRC

1. Digital microwave links will allow a TDM mix of AD-HDTV and compressed digital NTSC. Existing digital microwave links can provide more than sufficient capacity for this. The AD-HDTV flexible data transport mechanism allows easy embedding of the digital NTSC data as a special service type. Required bandwidth is a function of the digital modulation technique; QPSK and QAM are commonly used.

2. Analog microwave links may handle AD-HDTV as an additional 6 MHz baseband signal. An FDM arrangement would need about 12 MHz including guardband. FDM is typically applied at some Intermediate Frequency.

MIT

1. Digital HDTV signals are compressed to 6 MHz and digital NTSC signals are compressed to 3 MHz. FDM multiplexing of the two would be most appropriate. The modulation would be on the microwave channel 32-QAM.

27. What signal form is anticipated for contribution circuits for production? Are different quality levels provided? Have you considered both satellite and terrestrial common carrier delivery? Assuming the production processes listed in 4 above, how many times through the signal form can an image go while retaining acceptable production quality in the resulting picture? Have you tested this experimentally?

<u>NHK</u>

1. Digitally compressed SMPTE 240M will be used for contribution. Two quality levels will require 60 Mb/s and 120 Mb/s, respectively. These bit rates can provide signal quality sufficient for post-production purposes.

2. For the 60 Mb/s signal, two concatenations of coding/decoding are possible. For the 120 Mb/s signal, more than five concatenations of coding/decoding are possible.

3. Lower bit rates might be possible for lower performance sources. Lower performance sources are not recommended, however, for the reasons given in the answer to B.2.

<u>GI</u>

1. Use of higher rate transmission is recommended for contribution circuits for production, as discussed in the answers to 3-5 above.

<u>Zenith/ATT</u>

1. Modest compression in two dimensions (no motion compensation) will provide very good quality for cutting, keying, and image manipulation.

2. Two-dimensional compression of DSC-HDTV in the order of 200 MHz is being actively pursued. Results are not yet ready for publication.

3. See the answers to B.2-B.5 above for more information.

<u>ATRC</u>

1. Contribution signals are expected to be MPEG compressed video at data rates appropriate for satellite and terrestrial circuits. Contribution and distribution will most likely differ in the amount and type of compression/decompression, e.g. motion-compensated vs. spatial. (See also answer to Question 3.) Contribution standards should be carefully related to the terrestrial simulcast standard just as in the case of distribution standards.

2. There are many possibilities that have cost/performance tradeoffs. Decisions on these issues should be made by the industry.

MIT

1. Contribution circuits may use same signal format as broadcast link. Higher data rate is useful if signal is to be further processed. Other signal formats also acceptable. Production quality after multiple encode/decode passes not tested but expected to depend strongly on data rate used. See also answer to B.3.

Cable

Q1. What provisions are made for conditional access without decoding the signal? Is partial decoding required? How complex is the equipment required to accomplish these functions?

NHK

1. The conditional access planned is the same as developed for fullband MUSE. This combines line rotation and line permutation. It is described in the Narrow MUSE System Description document.

2. There is no need to decode the video signal to recover the key information, but the digital data during the vertical blanking interval must be decoded.

3. Equipment complexity for N-MUSE is the same as for fullband MUSE, where an encoder takes one rack with three shelves and a decoder currently uses six chips in addition the N-MUSE encoder and decoder hardware. This will be reduced in commercial equipment because current equipment is prototype hardware.

GI

1. Protocol designed to support conditional access without decoding. Cable headend could insert or delete authorization information without decoding signal.

2. Equipment needed is not complex and can be done either at a source or downstream. Scrambling can be done by bit-by-bit Exclusive OR'ing with a pseudo-random data stream. Channel synchronization and data stripping can be done while maintaining the picture in a scrambled mode.

Zenith/ATT

1. Conditional access, i.e. insertion and capture of address/enable instructions, can be accomplished without decompressing the fully compressed 21.5 Mb/s signal. Channel synchronization, clocks, and general timing information are neither video encoded nor encrypted when the program is encrypted.

2. Encryption of the program can take many forms, one of which is the stream-cipher process contemplated. This process adds a known (but secret) pseudo-random number series to the message (program) data stream. Decrypting is the complementary process.

3. With key passing and addressing accommodated with the ancillary data channel, either encrypting or decrypting can be carried out any any point, origination or downstream, with simple equipment and without decompressing the 21.5 Mb/s (or any other) signal.

ATRC

1. Conditional access data can be decoded without decoding video and audio. It can be treated as a separate service type or included with the video/audio data.

2. Receivers can be built to decode only conditional access data and then to decode video and audio only after receiving authorization.

3. Digital encryption can be performed at any downstream point. AD-HDTV offers several layers at which encryption may be applied.

MIT

1. Decoding not required for conditional access data (or for Auxiliary data or Audio data). Such operations are very simple, given the digital time-division-multiplexed nature of the signal.

2. The scrambling operation is straightforward. It can be done at the source or downstream. Channel synchronization and data stripping can be accomplished with a scrambled picture.

Q2. See questions 3, 4, 5 & 6 under Broadcast above.

NHK

1. See answers to 3-6 under Broadcast.

GI

1. See answers to 3-6 under Broadcast.

Zenith/ATT

1. See answers to 3-6 under Broadcast.

ATRC

1. Signal distribution to most headends is anticipated to be in final compressed form, requiring on the order of 20 Mb/s, which is easily achieved on a satellite using QPSK.

2. The layered architecture of AD-HDTV allows headends to decode QPSK symbols into a serial data stream and then encode the bits either as SS-QAM or conventional QAM in a 6 MHz channel.

3. Local commercial insertion may be accomplished simply and economically by taking advantage of the spatially-coded frames that occur on a periodic basis in MPEG compression. This allows artifact-free cuts to be made on Group of Pictures (GOP) boundaries, even in the highly-compressed transmission format.

MIT

1. See answers to 3-6 under Broadcast.

Common Carrier

Q1. What form of signal do you propose for transmission over terrestrial common carrier links?

<u>NHK</u>

1. There will be two signal formats, with three quality levels total:

   - Compressed SMPTE 240M with 120 Mb/s for contribution
   - Compressed SMPTE 240M with 60 Mb/s for distribution
   - Digitally compressed Narrow MUSE at 40 Mb/s, reduced from the normal 78 Mb/s of digital N-MUSE

<u>GI</u>

1. The DigiCipher HDTV signal is packetized and can be transmitted along with other forms of data over common carrier links such as fiber or microwave.

<u>Zenith/ATT</u>

1. See Broadcast section, Question 3.

<u>ATRC</u>

1. Transmission is expected within the B-ISDN/ATM framework. The 148 byte data cells of AD-HDTV can be repackaged into ATM's 53 byte data cells. The AD-HDTV layered architecture allows the repackaging to be completely transparent to higher layers, namely, video and audio compression.

2. The data structures are applicable at any data rate from the fully compressed 20 Mb/s signal to the high performance, lower-compression signals.

<u>MIT</u>

1. The (compressed) baseband digital signal can be easily multiplexed onto common carrier links. The baseband digital signal is 26.43 Mb/s for 32-QAM operation.

Q2. Are the SONET bit rates assumed the correct choices?

NHK

1. The SONET bit rate choice of 360 Mb/s is correct for N-MUSE. This value permits multiples of the digitally compressed SMPTE 240M signals (both at 60 Mb/s and at 120 Mb/s) and of the digitally compressed Narrow MUSE to fit well in a single SONET channel.

GI

1. SONET data rates are high enough but have not been specifically studied.

Zenith/ATT

1. Two DSC-HDTV fully compressed 21.5 Mb/s data streams can be accommodated within the basic SONET modular data rate of 51.84 Mb/s.

2. For the 100 Mb/s 2D compressed format, a SONET STS-2 rate of 103.68 Mb/s can be used.

3. For the 200 Mb/s 2D compressed format, a SONET STS-4 rate of 207.36 Mb/s can be used.

ATRC

1. Any data rate on the order of 20 Mb/s is sufficient. This assumes that, particularly during the transition period, distribution will most frequently be at the level of compression used for transmission and that local affiliates/headends will perform minimal decompression and processing of the signal.

2. Two 24 Mb/s AD-HDTV data streams may be accommodated by the SONET 51.84 Mb/s rate. Similarly, higher data rate signals may be accommodated by the 103.68 Mb/s and 207.36 Mb/s SONET rates.

MIT

1. Bit rate depends on the application and quality desired. Any of the digital hierarchies supplies rates that seem to be appropriate.

Q3. What bit error rates does your proposed distribution format require of the transport system? Your production contribution format?

NHK

1. Lower than 10^{-6}.

GI

1. The issue is not what error rates are objectively required but what can be tolerated subjectively. Uncorrected errors introduced in distribution or contribution channels should be reduced to the minimum cost effectively achievable.

2. Suggested minimum requirement of less than one uncorrectable error per 10 minutes for distribution and less than one per hour for contribution, corresponding to raw error rates of 1.7×10^{-2} and 1.4×10^{-2}, respectively.

Zenith/ATT

1. A BER of 10^{-4} is satisfactory for both distribution and contribution.

ATRC

1. BER requirements for distribution and contribution will depend on the amount of compression that is used and the error handling capabilities that are designed into them.

2. AD-HDTV has been carefully designed to tolerate packet error rates on the order of 10^{-3}, corresponding to a raw BER of 10^{-1}. BER requirements for distribution and contribution must be significantly lower. Very conservative BER requirements are generally planned in the specification of digital links.

MIT

1. Operates over wide range. "Transparent" error rates might be 10^{-9} for distribution and 10^{-11} for production at the output of the Reed-Solomon decoder, although much higher error rates can be tolerated. If the system carried the same amount of data without error correction, the BER would have been approximately 10^{-2}.

Consumer

Q1. What is required in a consumer VCR for the system? When will such a VCR be available? Is new technology required first? What format is to be recorded? Are any current VCR features not possible with this format? Have you verified this experimentally?

NHK

1. For an analog VCR, no new technology must be developed because the bandwidth of N-MUSE is the same as that of NTSC. A consumer VCR will become available within two years after the FCC decision.

2. Narrow MUSE can be recorded using FM, as with NTSC. The sync circuit in the current VCR design must be modified. Chroma circuitry can be removed. A time base corrector is required.

3. Technology for a 40 Mb/s consumer VCR capable of two hours of digital recording is already available. A digital consumer VCR will become available within two years of the FCC decision.

4. The distinction of moving and stationary areas, as provided by the use of the motion vector, is essential to obtain the full capability of N-MUSE. Whether or not an N-MUSE decoder can perform these functions in VCR stunt modes depends on the decoder design. With proper decoder design, the N-MUSE signal can be fully decoded in slow, still, and reverse motion.

GI

1. A consumer VCR for DigiCipher HDTV has been demonstrated recording and playing back the 18.22 Mb/s of a fully-compressed DigiCipher HDTV signal. Implementation of current VCR playback features has been studied, and it is believed that a full set can be implemented. This has been substantiated through simulation.

2. Speed search functions will utilize PCM (intraframe) refresh data, which is used to continuously refresh one-eleventh of the picture each frame and thus the whole picture every 11 frames. There are no restrictions on speeds caused by the technique.

Zenith/ATT

1. The level of mechanical and electronic technology of current full-featured S-VHS VCR's will be appropriate for the fully-compressed DSC-HDTV signal at 21.5 Mb/s.

2. Consumer grade VCR's will be available at about the same time as DSC-HDTV receivers.

3. Most features are possible. Speed search simulations have yielded satisfactory results.

ATRC

1. Consumer VCR's require tradeoffs between compression format and data rate. The lowest cost VCR would directly record the transmitted data in compressed form. No new head/tape technology will be required for such a recorder.

2. The periodically occurring, spatially coded frames of MPEG compression provide advantages in achieving features such as search modes. These capabilities have not been demonstrated in experimental hardware.

3. The constant bit rate of AD-HDTV results in simpler data handling/reformatting in a VCR as compared to other systems with variable bit rate transmission.

4. All features are expected to be available in top-of-the-line models. Low cost models may have fewer features. The frame-based compression in AD-HDTV has no significant impact on search mode performance, but it does permit full-resolution stills to be presented in freeze-frame mode.

MIT

1. The signal may be directly recorded in digital format. Current VTR features possible, but very flexible control (i.e. arbitrary-rate, undegraded fast-forward and rewind) may require higher data rate and less recursive format.

2. Rewind search operations will utilize the intra-frame encoding mode. One twentieth of each frame is refreshed continuously, thereby encoding three frames/second using the intra-frame mode. These frames can be used for rewind search mode.

Q1. Is it possible to carry the ATV signal and an NTSC signal on the same transponder? If so, at what bandwidth? What other multiples are possible with your system?

NHK

1. Required quality level determines the bandwidth needed for simultaneous transmission of ATV and NTSC signals. When the signal formats described in answer to Common Carrier Question 1 are used for satellite transmission, the bit rates and bandwidths for QPSK operation are as shown in the following table:

ATV	NTSC	Total bit rate	Bandwidth
40 Mb/s	17 Mb/s	57 Mb/s	34 MHz
60 Mb/s	17 Mb/s	77 Mb/s	46 Mb/s
120 Mb/s	34 Mb/s	144 Mb/s	92 Mb/s

8ϕ PSK can also be used.

2. Narrow MUSE can also be transmitted using conventional FM modulation. In such a case, 45 MHz is required to transmit both N-MUSE and NTSC as described in the answer to Question 5 in the Broadcast section above.

GI

1. It is possible. One HDTV and two NTSC signals can be carried within 24 MHz using QPSK.

Zenith/ATT

1. See Broadcast section, Question 6.

ATRC

1. Analog satellite links can use an FDM arrangement of AD-HDTV on a QPSK carrier, occupying 6 MHz at baseband, with NTSC on an FM carrier. FDM could be performed at either RF or IF. This could be accomplished using standard transponders, with a lower modulation index for NTSC. This would lower the CNR threshold for NTSC.

2. With digital satellite links providing about 60 Mb/s, a TDM mix of AD-HDTV and/or compressed digital NTSC can be carried. Three AD-HDTV channels can also be carried in a single transponder. C-band (K-band) satellites can deliver 60 Mb/s using a 36 MHz (54 MHz) transponder with QPSK modulation.

MIT

1. Transponder bandwidths are typically between 36 and 72 MHz. FDM can be used to carry both ATV and NTSC signals. TDM can also be used to carry ATV and digital NTSC signals. The CCDC HDTV signal would require 12 MHz bandwidth using QPSK modulation (8PSK trellis coded). A single transponder can easily carry several CCDC-HDTV signals.

Q2. See questions 3 & 7 under Broadcast above.

NHK

    1. See the answers to 3 and 7 under Broadcast.

GI

    1. See the answers to 3 and 7 under Broadcast.

Zenith/ATT

    1. See the answers to 3 and 7 under Broadcast.

ATRC

    1. See the answers to 3 and 7 under Broadcast.

MIT

    1. See the answers to 3 and 7 under Broadcast.

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Glenn Reitmeier
Director
High Definition Imaging
and Computing Laboratory

Dear Merrill: August 19, 1992

Thank you for the draft Summary of Responses to IS/WP2
questions that you distributed. Attached to this letter,
please find the ATRC reply to the draft Summary. It points
out areas that we feel do not fully reflect the attributes of
AD-HDTV and the capabilities of ATRC.

We are looking forward to an appropriate update of the
Summary of Responses document and to subsequent
discussions in IS/WP2.

Sincerely,

Glenn A. Reitmeier

/jtm

ATRC REPLY TO IS/WP2 SUMMARY OF RESPONSES
AUG. 16, 1992

Although most of the draft Summary of Responses document provides a good summary of ATRC responses, it is essential that the following points be made in order to accurately reflect the attributes of the AD-HDTV system. Minor additions to previous responses have been made where we believe that they will clarify our previous responses.

GENERAL

1.   EXTENSIBILITY

Headers/descriptors of the type under consideration by SMPTE can be readily accommodated by assigning a service type for such global headers.

MPEG itself contains header/descriptors to provide for video format flexibility.

AD-HDTV's transport cell format is fully described in our System Description document.

2.   TECHNICAL INFORMATION

The anticipated 6 months includes time to work in collaboration with industry experts and FCC officials.

3.   MANUFACTURERS

An effective technology transfer plan must include broadcast equipment manufacturers, consumer electronics manufacturers, display manufacturers and semiconductor manufacturers. ATRC has the required technical base and business presence in all of these areas to ensure effective technology transfers across all industry segments.

4.   ICS

ATRC members (Thomson-ST and Philips-Signetics) are already large consumer electronics industry suppliers, and will continue to be for AD-HDTV components. Each is experienced in providing multiple sourcing agreements with other manufacturers.

BROADCAST

1.   POWER LEVELS

Note that the different average power level for Hi V band is a result of different planning factors that are required in the different bands, as well as differences in the conversion from